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Research Note
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Mountain Pine Beetle Selection of Dwarf Mistletoe and Comandra Blister Rust Infected Lodgepole Pine

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ABSTRACT

Pairs of similar-size lodgepole pine—one attacked by mountain pine beetles and the other not attacked—were compared as to the degree of dwarf mistletoe and comandra blister rust infection they had. The data showed some evidence (one forest had a significant difference) that beetles chose to attack trees with heavier infections of comandra blister rust. On the other hand, due to the high incidence of dwarf mistletoe in the areas examined, comparisons of beetle/dwarf mistletoe interactions were difficult.

KEYWORDS: *Dendroctonus ponderosae, Arceuthobium americanum, Cronartium comandrae, Pinus contorta*

INTRODUCTION

Incidence of bark beetle infestation has long been associated with weakened, decadent, or overmature trees. Consequently, most investigations into the causes of outbreaks of bark beetles have been concerned with factors that weaken the tree, thereby making invasion and killing of the tree by beetles possible. However, Amman (1969, 1972), Cole and Amman (1969), and Roe and Amman (1970) found that large-diameter lodgepole pine (*Pinus contorta* var. *latifolia* Engelm.) with thick phloem make possible the buildup of mountain pine beetle (*Dendroctonus ponderosae* Hopkins) populations and, hence, large infestations of this beetle in lodgepole pine forests. Furthermore, thickness of phloem, the food source of developing larvae, is closely related to positive factors of host vigor (D. M. Cole 1973). These observations of the variables that result in increased beetle populations are in direct opposition to the theory that weak trees and mountain pine beetle epidemics go together.

A first step in the resolution of this controversy is to determine if mountain pine beetles attack lodgepole pine on the basis of degree of dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.) and comandra blister rust (*Cronartium comandrae* Pk.) infection.

Dwarf mistletoe is a parasitic seed plant that has separate male and female plants. The plant consists of an aerial portion and a network of absorbing strands that are hidden in, and obtain nourishment from, the cortex and xylem of the host tree (Hawksworth and Dooling 1984). During the initial years of infection, tree growth in the immediate area of the mistletoe strands is stimulated, resulting in wide annual rings and thick phloem. Ultimately, high dwarf mistletoe infections retard growth of the host and may lead to premature death of the tree.

Studies directed specifically at the incidence of mountain pine beetle infestation in lodgepole pine trees infected by dwarf mistletoe are few in number, although the literature frequently indicates that this interaction may be important. Parker and Stipe (1974) found that the mistletoe infection rate of lodgepole pine ranged from 54 to 85 percent of the trees in three study areas, and that trees with a mistletoe rating of 4, 5, or 6 (Hawksworth's 1977 system, see explanation in next section) ranged from 19 to 46 percent for the three stands. Trees killed by the beetle had mistletoe ratings averaging between 3 and 4. They interpreted their findings as indicative that mountain pine beetles select mistletoe-infected trees. However, the large amount of mistletoe infection in the stands makes positive conclusions about the interaction of beetle and dwarf mistletoe difficult.

McGregor (1978) reported that lodgepole pine stands with the least mistletoe infection suffered the greatest mortality from mountain pine beetle infestations.

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Roe and Amman (1970) observed that dwarf mistletoe infection was highest and losses to the mountain pine beetle were lowest in the *Abies lasiocarpa/Vaccinium scoparium* habitat type. However, an overriding factor with respect to reduced losses in this habitat type is climate. Much of this habitat type is at high elevations; consequently, the effect of climate on beetle populations could have significantly reduced beetle survival and, hence, losses to the beetle. Roe and Amman (1970) observed that the phloem thickness at breast height was significantly thinner ($P = 0.05$) in trees that had medium to heavy mistletoe crown infections when compared to trees with no infection. Therefore, the association of mountain pine beetles with dwarf mistletoe infected trees could prove detrimental to the beetle population in that brood production could be below the replacement rate. In contrast, Hawksworth and others (1983) in a Colorado study report a much less significant relationship between lodgepole pine phloem thickness and dwarf mistletoe.

Comandra blister rust, caused by the fungus *Cronartium comandrae* Pk., also is a serious disease affecting lodgepole pine (Johnson 1986). The disease alternates between herbaceous comandra plants and pine hosts. The infections on pine develop in 2 to 4 years into spindle-shaped cankers. The cankers enlarge, eventually girdling the infected branch or stem. Girdling stem cankers result in spike tops and eventually can cause tree death. The larger lodgepoles, usually those in the higher crown classes, are the most frequently damaged (Krebill 1975). These are the same trees favored by mountain pine beetles.

Comandra plants generally occur as aggregated groups among sagebrush (Brown 1977), and the proximity of comandra plants to lodgepole pine stands can directly influence the severity of infection (Krebill 1965). In many stands, the heaviest amounts of infection tend to occur near the edge of stands (Brown 1977), a habit also characteristic of endemic populations of mountain pine beetles (Washburn and Knopf 1959).

Because most of the lodgepole pine stands infested with mountain pine beetles in the Intermountain area are to some degree infected with dwarf mistletoe or comandra blister rust or both, there is a need for knowledge of the relationship of these diseases to beetle dynamics. Therefore, a study was designed to assess the interaction of mistletoe and comandra blister rust on endemic beetle attack behavior on the Shoshone National Forest, WY, and Sawtooth National Forest, ID, where endemic populations of beetles were located.

Endemic infestations were selected because there is an opportunity to study tree selection behavior more closely than in outbreak situations where large numbers of trees are being attacked, resulting in fewer live trees for the beetle to choose from.

MATERIALS AND METHODS

Mountain pine beetle attack behavior was determined once emerging beetles started attacking green trees in early August. We conducted a daily search of each area to locate and mark newly infested trees. Only trees that were successfully mass attacked were used. We rated these trees as to the degree of dwarf mistletoe infection, using Hawksworth's (1977) 6-class system, and the degree of comandra blister rust infection using Brown's (1977) 8-class system. In Hawksworth's system the live crown is divided into thirds, each third being rated from 0 (no infection) to 2 (heavy infection). The ratings of each third are added to obtain mistletoe rating for the entire tree. In Brown's system, the crown, both live and dead portions, is divided into thirds, and the most damaging canker in each third is rated as to girdling or nongirdling on a scale with highest ratings in lowest third. The ratings from each third are then added to obtain the total tree rating.

We then located the nearest tree uninfested by the beetle and of similar size, plus or minus 1 inch diameter at breast height (d.b.h.). We rated the uninfested tree as to degree of mistletoe and comandra blister rust infection. Additional data collected from these trees included d.b.h., phloem thickness, annual increment for the previous 10 years, and number of mistletoe-caused brooms.

RESULTS AND DISCUSSION

Although the data sets are small, they represent 100 percent of the mountain pine beetle-infested trees that could be located within a drainage in each Forest. At the time, the Shoshone infestation was characterized by small, scattered groups of three to four trees each, whereas the Sawtooth infestation consisted of a single group of 18 infested trees. The stands in both study areas were almost pure lodgepole pine, with a minor component of subalpine fir (*Abies lasiocarpa* [Hook.] Nutt.) and aspen (*Populus tremuloides* Michx.).

Using a paired T-test, no significant differences were found in any data sets. Table 1 shows only small differences between the trees attacked by mountain pine beetles and the nearest uninfested tree of similar size. Attacked trees had, on the average, higher comandra blister rust

Table 1—Paired T-test comparison[1] of pairs of lodgepole pine trees—one attacked by mountain pine beetles, the other the nearest similar-size tree not attacked

Comparisons	Forest	
	Shoshone	Sawtooth
Average rust rating		
Attacked	2.5	1.1
Unattacked	1.6	.2
Average mistletoe rating		
Attacked	5.6	6.0
Unattacked	5.8	5.7
Average number of mistletoe brooms		
Attacked	1.6	.8
Unattacked	1.7	.8
Average phloem thickness		
Attacked	.09	.10
Unattacked	.09	.10
Average 10-year growth		
Attacked	.022	.034
Unattacked	.020	.029

[1]None were significant at 0.05 level of probability.

Table 2—Chi-square test of number of trees infected with comandra blister rust and mistletoe on Shoshone and Sawtooth National Forests

	With comandra blister rust	No comandra blister rust	With mistletoe	No mistletoe	With brooms	No brooms
Shoshone trees:						
Attacked	19	7	26	0	14	12
Green	19	7	26	0	16	10
	[1]	[1]	[1]	[1]	[1]	[1]
Sawtooth trees:						
Attacked	6	12	18	0	8	10
Green	1	17	18	0	6	12
	$P < 0.05$	[1]	[1]	[1]	[1]	[1]

[1]Not significant.

ratings and were growing a little faster. There were little or no differences in mistletoe ratings, number of brooms, or in phloem thickness.

In comparing numbers of trees with and without mistletoe or comandra blister rust infection with a Chi-square test, we found only one case of a statistically significant difference. On the Sawtooth, six out of 18 beetle-attacked trees had a comandra blister rust infection, whereas only one of 18 unattacked trees had a comandra blister rust infection (table 2).

There appears to be some evidence that mountain pine beetles select lodgepole pine on the presence of comandra blister rust infection, at least on the Sawtooth National Forest. The high incidence of mistletoe in both forests makes comparisons of beetle/mistletoe interactions difficult. Additional evaluations of mountain pine beetle and tree pathogen interactions, particularly in endemic situations, are needed to determine the triggering mechanisms of epidemics.

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